



Alberta
ENVIRONMENT

AIR QUALITY SURVEY
- SUSPENDED PARTICULATES

TOWN OF DRAYTON VALLEY

September 5 to December 3, 1989



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EXECUTIVE SUMMARY

Alberta Environment conducted a suspended particulate monitoring program in the Town of Drayton Valley during the autumn of 1989. This program was initiated in response to concerns voiced by local residents regarding a noticeable amount of wood and ash particulate fallout evident in the Town of Drayton Valley.

Suspended particulates were monitored by a network of four high volume samplers from September 5 to December 3, 1989, and one dichotomous sampler from November 10 to December 3, 1989. The dichotomous sampler was set up to monitor inhalable particulates in support of a coincident indoor air quality monitoring program. Suspended particulate data was analyzed for total suspended particulate (TSP) loading, particle identification, and quantification of the primary constituents of particulate loading. The results were compared with wind direction frequencies so that source identification would be possible.

Total suspended particulate loadings exceeded the Alberta Environment regulation of $100 \mu\text{g}/\text{m}^3$ in 13 percent of the samples on 21 days during the monitoring period. The particles identified during exceedances consisted mainly of dust. The most likely sources being road dust or dust generated during agricultural practices (harvest).

Wood particles were the major particulate in 23 percent of the samples. None of these samples exceeded the Alberta Environment regulation for TSP loading. A wind direction frequency distribution revealed that the greatest source of wood particulates is located in the southwest and south-southwest areas of Drayton Valley. A source of Benzo-a-Pyrene (BaP) was also located in the southwest and south-southwest areas of Drayton Valley. The most probable source of BaP is the combustion of wood. Evidence also suggest that potassium (K), titanium (Ti) and iron (Fe) may emanate from sources in the southwest and south-southwest areas of town.



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We would also like to acknowledge Mobil Oil Ltd., the Church of Jesus Christ Latter Day Saints and the Town of Drayton Valley for providing site locations and electric power for the monitoring stations, and the Alberta Environmental Centre for their technical support.

We would also like to thank the Pelican Steering Committee of the Town of Drayton Valley for their assistance on site selection and basic study design.

1. INTRODUCTION

Alberta Environment was requested by the Town of Drayton Valley and Alberta Health to monitor for total suspended particulates (TSP) within the town limits. The monitoring network consisted of four high volume samplers and one dichotomous sampler. TSP were monitored by the high volume samplers for a 90-day period from September 5 to December 3 1989. The dichotomous sampler was set up to monitor coarse and fine inhalable particulates, in support of an indoor air quality study contracted by Alberta Health, for a 24-day period from November 10 to December 3 1989. A wind speed and direction monitor was co-located at one of the high volume sampler sites. Locations of the monitors are shown in Figure 1-1.

1.1 TOPOGRAPHY

Local topography is defined by the North Saskatchewan River which is oriented north-northeast to south-southwest and is located approximately 2.5 km east of the Town of Drayton Valley. Terrain in the region consists of small, partially tree-covered hills with elevations generally decreasing towards the North Saskatchewan River. There is significant agricultural activity in the Drayton Valley region.

A small hill, with a northwest to southeast orientation, runs through downtown Drayton Valley. Terrain elevations to the northeast and southwest of this hill are somewhat lower than the downtown area. Local topography is illustrated in Figure 1-2.

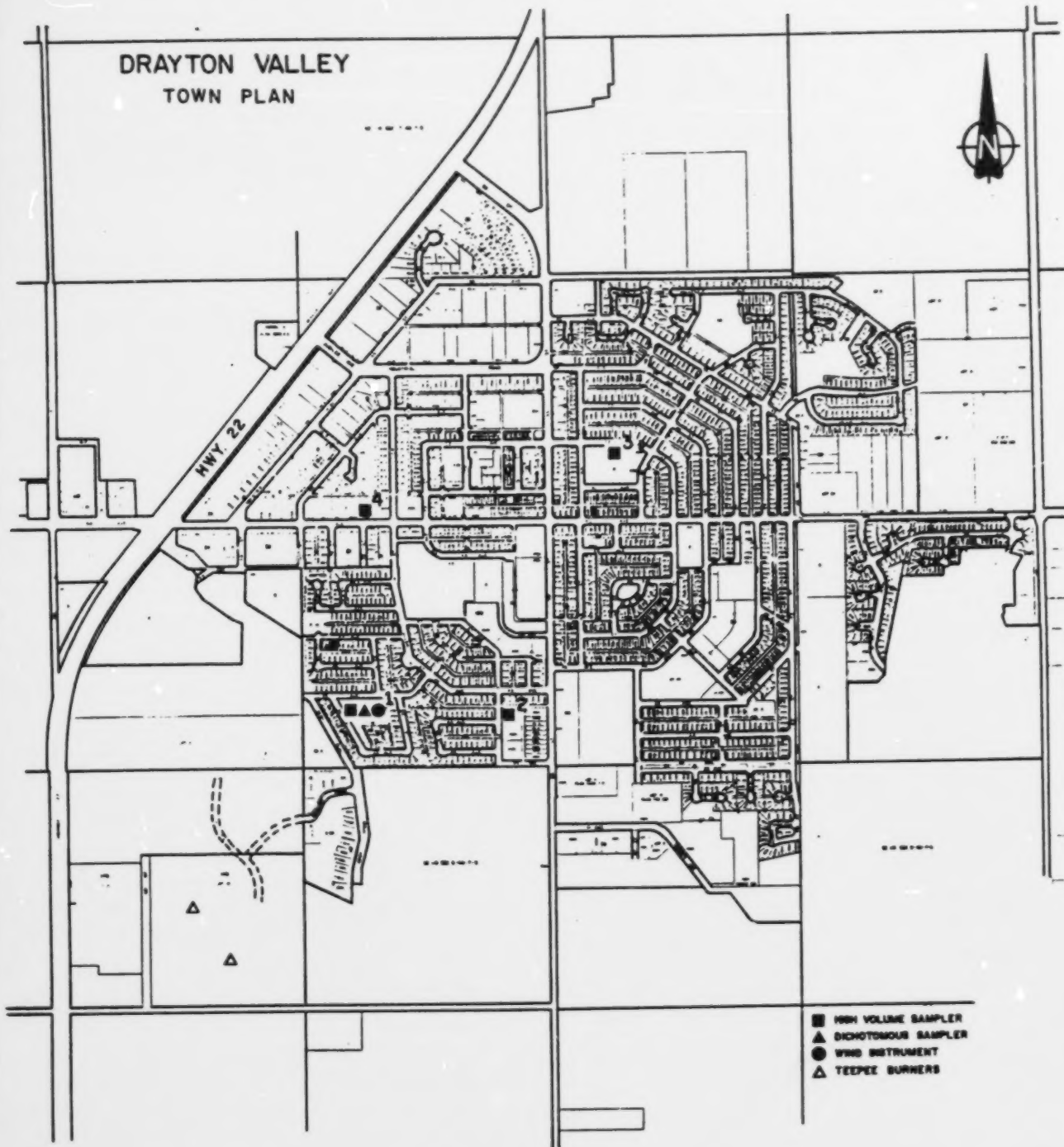
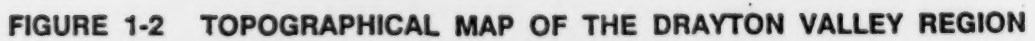


FIGURE 1-1 LOCATION OF TOTAL SUSPENDED PARTICULATE
MONITORING NETWORK



2. DESCRIPTION OF AIR QUALITY MONITORING PROGRAM

The air quality monitoring program consisted of a network of four high volume samplers and one dichotomous sampler. The high volume sampler was operated for a 90-day period from September 5 to December 3, inclusive, while the dichotomous sampler operated from November 10 to December 3, inclusive. Wind speed and direction were also measured from September 5 to December 3, inclusive.

2.1 SITE DESCRIPTION

The high volume samplers were located at sites #1 to #4 as indicated in Figure 1-1. The dichotomous sampler and wind instrument were co-located at site #1. Routine operation of site instrumentation was conducted by volunteers who are residents of Drayton Valley. Each site is described as follows:

- Site #1 - located in a residential region of southwest Drayton Valley at the base of the hill running through downtown. Access to the site was on a grass covered surface.
- Site #2 - situated halfway up the hill towards downtown in the south part of town. This site was located in a churchyard within close proximity to an unpaved back alley.
- Site #3 - located a few blocks east of downtown on top of the hill. Access to the site was by an unpaved road.
- Site #4 - located in the west part of town near a main traffic artery running east-west through town. This traffic artery is frequently utilized by heavy trucks. This site was located at approximately the same elevation as site #2.

2.2 INSTRUMENTATION

2.2.1 High Volume Sampler

The high volume sampler consists of a vacuum system and filter housed in a shelter and operates on the same principle as a vacuum cleaner. The total suspended particulate matter in the atmosphere is collected by drawing a known volume of air through a pre-weighed filter for a 24-hour period. Suspended particulates with a diameter range from 0.1 to 100 microns (μ), Stokes equivalent, will be collected on the filter (Environment Canada, 1973). The filter is then reweighed to determine the mass of the particles collected. The total particulate concentration for the 24-hour period may then be calculated.

2.2.2 Dichotomous Sampler

The dichotomous sampler is a derivative of the high volume sampler. The sampler aerodynamically separates the particulates into two size fractions; fine ($<2.5 \mu$) and coarse (2.5 to 10μ). Fine and coarse particulates are collected by drawing a known volume of air through two individual pre-weighed filters for a 24-hour period. The total particulate concentration in the two size ranges may then be calculated for the 24-hour period.

2.3 AIR QUALITY PARAMETERS AND REGULATIONS

Monitoring conducted by utilizing high volume samplers and dichotomous samplers will result in a direct measurement of atmospheric loadings of suspended particulates. Further analysis of suspended

particulate matter, through electron microscope analysis, energy dispersive x-ray fluorescence (EDXRF) and high pressure chromatography, can reveal the primary constituents of particulate loading. The constituents of interest include Benzo-a-Pyrene (BaP), lead (Pb), bromium (Br), chlorine (Cl), calcium (Ca), titanium (Ti), iron (Fe), potassium (K), zinc (Zn), copper (Cu), and chromium (Cr). There are currently no regulations for these constituents in Alberta.

2.3.1 Total Suspended Particulates (TSP)

Air pollutants are not necessarily in the gaseous form. Tiny particles of solid material or liquid droplets, defined collectively as particulates, are also present in the air in great numbers, and may constitute a pollution problem. The particles range in size from 0.001 to 500 μ (a human hair is about 100 μ in diameter) and, depending on their size and other properties, may remain suspended in the air for a few seconds or indefinitely.

In general, particles smaller than 1 μ in diameter originate in the atmosphere, principally as a by-product of condensation and combustion. Particles between 1 μ and 10 μ in diameter usually include soil, process dusts, and combustion products from industries. Particles larger than 10 μ in diameter generally result from mechanical processes such as wind erosion, grinding, spraying and vehicular activity.

Since particulates enter the body through the respiratory system, most of their immediate effects are upon this system. The factor determining the depth of penetration into the respiratory system is the particle size. Larger particles tend to deposit in the upper respiratory tract, such as the

nose and throat, while smaller inhalable particulates travel deeper into the lungs where removal is less rapid and complete. Inhalable particulates are typically less than $15\ \mu$ aerodynamic diameter (Environment Canada, 1983). The toxicity of the particles, however, varies with the chemical composition.

Suspended particulates may result from a variety of natural and man-made sources. These sources include soil, road dust, dust resulting from other human activities (i.e., agriculture), smoke from forest fires, smoke from recreational sources (i.e., camp fires and fireplaces), vehicular exhaust emissions, and industrial emission sources.

Regulations governing the maximum permissible levels of TSP are based on visibility reduction and nuisance effects. Alberta has adopted the most rigorous federal standards for maximum permissible TSP loadings. The maximum permissible 24-hour total and annual average TSP loadings are $100\ \mu\text{g}/\text{m}^3$ and $60\ \mu\text{g}/\text{m}^3$, respectively.

2.3.2 Benzo-a-Pyrene (BaP)

Benzo-a-Pyrene is formed during the combustion of organic materials and is present in all types of soot and smoke. The prime sources are heat and power generation, refuse burning, coke production and motor vehicle emissions.

Measurements of BaP are recorded at various urban and rural locations in Alberta on a routine basis. In the month of November 1989, average monthly BaP loadings in Alberta ranged from $0.9\ \mu\text{g}/\text{g}$ of particulate at Lethbridge to $27.5\ \mu\text{g}/\text{g}$ of particulate at the Edmonton monitoring station located in the vicinity of 127 St. and 133 Ave. The highest BaP loading observed in Alberta during the month of November 1989 was $42.0\ \mu\text{g}/\text{g}$ of particulate. This value

was recorded at the Edmonton monitoring station. The primary source of BaP at this Edmonton location is likely vehicular emissions.

2.3.3 Lead (Pb)

Lead in the ambient air exists primarily as particulate matter of inhalable size. Its presence in the atmosphere is largely from man-made processes such as iron and steel production, solid waste incineration, battery manufacturers and especially the operation of motor vehicles.

The burning of "leaded" gasoline by motor vehicles is the largest source of airborne lead emissions. Lead is emitted from vehicle exhaust in the form of lead vapors, lead alkyls, very fine lead particles and organic halogens such as lead bromide, lead chloride and lead bromochloride. These compounds originate from the lead anti-knock additives used in gasoline.

2.3.4 Bromine (Br)

Bromine in the atmosphere is most commonly generated through automobile emissions. Ethylene dibromide is used as a leaded gasoline additive to scavenge the lead after combustion. The resulting compound of lead bromide is emitted by the automobile exhaust (Williamson, 1973).

2.3.5 Chlorine (Cl)

Atmospheric chlorine is most common from sources such as wind blown soil, road salt and sea salt in marine locations. Chlorine, in the form of hydrogen chloride, may be emitted from the incineration of refuse. Before incineration, chlorine may be bound in chlorinated plastics and chlorine

bearing vinyls. Ethylene dichloride may also be used as a gasoline additive for the scavenging of lead (Environment Canada, 1984; Williamson, 1973).

2.3.6 Calcium (Ca)

The most common natural sources of calcium are wind blown soil and road dust. Calcium, in the form of calcium oxide, is emitted as particulate matter from processes used in iron and steel manufacturing. Calcium oxide is also a major constituent of coal emissions (Fidalgo et al., 1988; Trier and Silva, 1987; Environment Canada, 1984).

2.3.7 Titanium (Ti)

Processes which may emit ash such as forest fires, recreational fires, and wood manufacturing are likely atmospheric sources of titanium. Titanium is also prevalent in wind blown soil and road dust (Trier and Silva, 1987; Cooper and Watson, 1980).

2.3.8 Iron (Fe)

Oxides of iron are generated by processes such as coal burning, wood manufacturing, refuse incineration, steel production and iron production. Ferrous oxide may be a catalyst in the oxidation of sulphur dioxide to sulphuric acid in the atmosphere. Iron is also a component of wind blown soil and road dust (Fidalgo et al., 1988; Trier and Silva, 1987; Cooper and Watson, 1980).

2.3.9 Potassium (K)

Potassium is a major constituent in the fly ash resulting from the burning of fossil fuels such as coal. Wood ash generated by forest fires, recreational fires and wood manufacturing industries may also contain significant quantities of potassium. Potassium will also occur naturally in wind blown soil and road dust (Fidalgo et al., 1988; Environment Canada, 1984).

2.3.10 Zinc (Zn), Copper (Cu), and Chromium (Cr)

Zinc, copper, and chromium generally exist in low quantities in the atmosphere. Sources of these elements include wind blown soil and road dust. Zinc will also result from solid waste incineration and vehicle tire abrasion while chromium is emitted in processes such as glass manufacturing (Trier and Silva, 1987; Environment Canada, 1984).

3. DATA ANALYSIS AND RESULTS

Data collected by the high volume samplers were analyzed for TSP loading, particle identification, and BaP loading. The dichotomous data underwent further analysis so that the primary constituents of particulate loading could be assessed. Analysis of the above-mentioned data as related to wind direction is presented.

3.1 ANALYSIS OF WIND DATA

Wind data collected at monitoring site #1 were unacceptable due to instrument malfunction for a large percentage of time during the monitoring period. For this reason, wind data monitored at three Transalta Utilities air quality monitoring stations in the Wabamun Lake area were assessed for

applicability to the Drayton Valley region. Upon scrutinization of the wind data from these three locations, it was decided that the data collected from the Transalta Utilities Sundance power plant air quality monitoring station located at Litwiniuk's pasture, approximately 40 km northeast of Drayton Valley, were the most representative. This location was chosen because of its proximity to Drayton Valley and because topographical features in the region did not significantly influence wind direction and wind speed.

Filters from the high volume and dichotomous samplers were generally changed between 10:00 a.m. and 11:00 a.m. every day by local residents. Wind data from Litwiniuk's pasture were analyzed on a 24-hour basis, from 11:00 a.m. to 10:00 a.m. for the months of September, October, and November 1989. This would enable a direct comparison of wind direction with high volume and dichotomous sampling data.

A frequency distribution of winds observed at Litwiniuk's pasture during the months of September, October, and November 1989 is presented in Figure 3-1. This figure indicates the percentage of time during the monitoring period that the wind was observed from a particular direction. Winds were observed to be predominantly from the south through to the southwest (32 percent) during the monitoring period. Relative maxima in wind directions from the west-northwest and northwest were also observed. Wind directions with an easterly component occurred least frequently at Litwiniuk's pasture during September, October, and November 1989.

3.2 TSP LOADING

A total of 360 samples of TSP were collected by the network of high volume samplers over the 90-day period. Of these samples, 12 were rejected

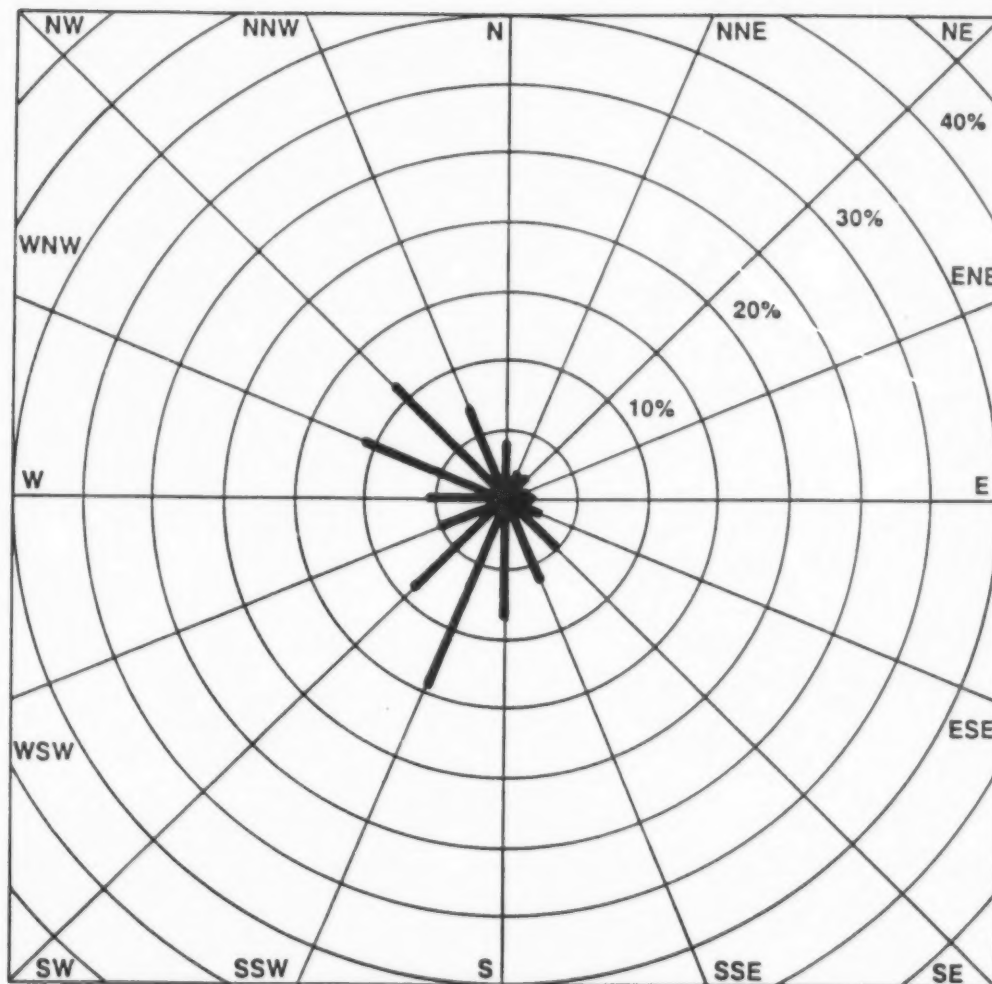
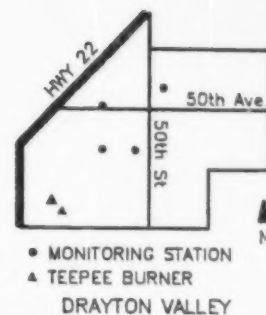


FIGURE 3-1 Wind direction frequency distribution for
September, October and November 1989

due to instrument malfunction. All samples were analyzed for total particulate loading.

Figures 3-2 to 3-5 show TSP loading on a day-to-day basis at the four high volume sampler locations. Samples which exceeded the Alberta Environment regulation for TSP and samples that were visually identified as containing wood particulates are also indicated in these figures. The maximum observed TSP loading was $270 \mu\text{g}/\text{m}^3$ which occurred at site #1 on September 28. Maximum TSP loadings at all sites were generally observed in late September.

A total of 46 samples exceeded the Alberta Environment regulation of $100 \mu\text{g}/\text{m}^3$ as a 24-hour total for TSP. A frequency distribution of TSP loading is presented in Figure 3-6. The frequency of exceedances ranged from 8.5 percent at site #3 to 21.8 percent at site #4. TSP concentrations for each sample are contained in Appendix 7.1.

Particulate matter resulting from the burning of wood was visually identified in 81 samples. The majority of these samples were collected in November and December. The maximum TSP loading of these samples did not exceed the Alberta Environment regulation of $100 \mu\text{g}/\text{m}^3$. The average and maximum loadings for these samples were $28.5 \mu\text{g}/\text{m}^3$ and $86.9 \mu\text{g}/\text{m}^3$, respectively.

3.3 PARTICLE IDENTIFICATION

Electron microscope analysis was conducted on samples which had particulate loadings greater than $100 \mu\text{g}/\text{m}^3$ and samples that were visually identified as having significant loadings of unburned and burned wood particles, and ash particles. This analysis would reveal the types of particles present in the samples. Appendix 7.2 details a complete list of particles identified for each of the sample sets.

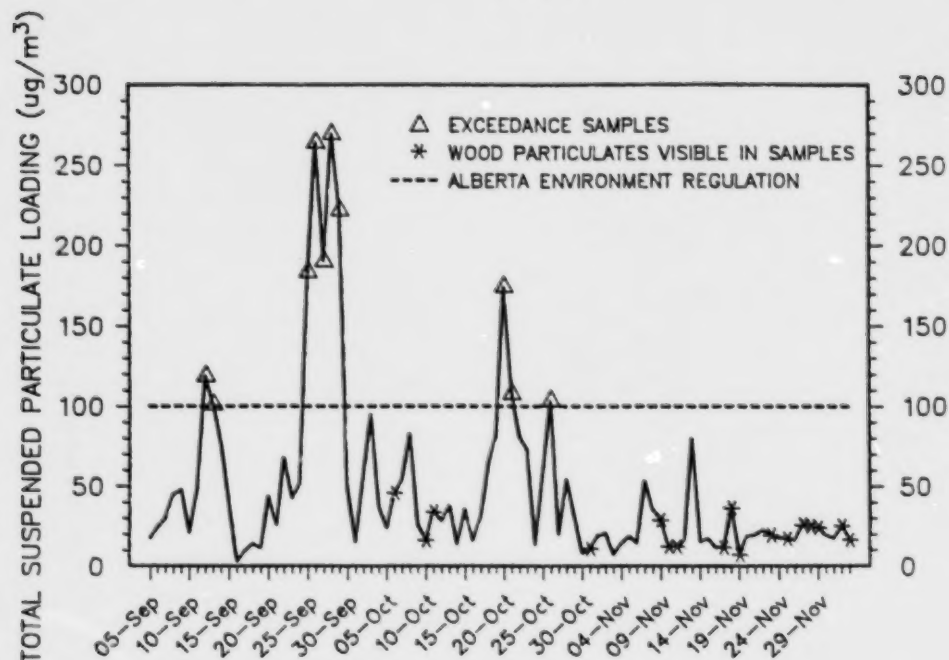


Figure 3-2 Total suspended particulate loading as a function of day at site #1

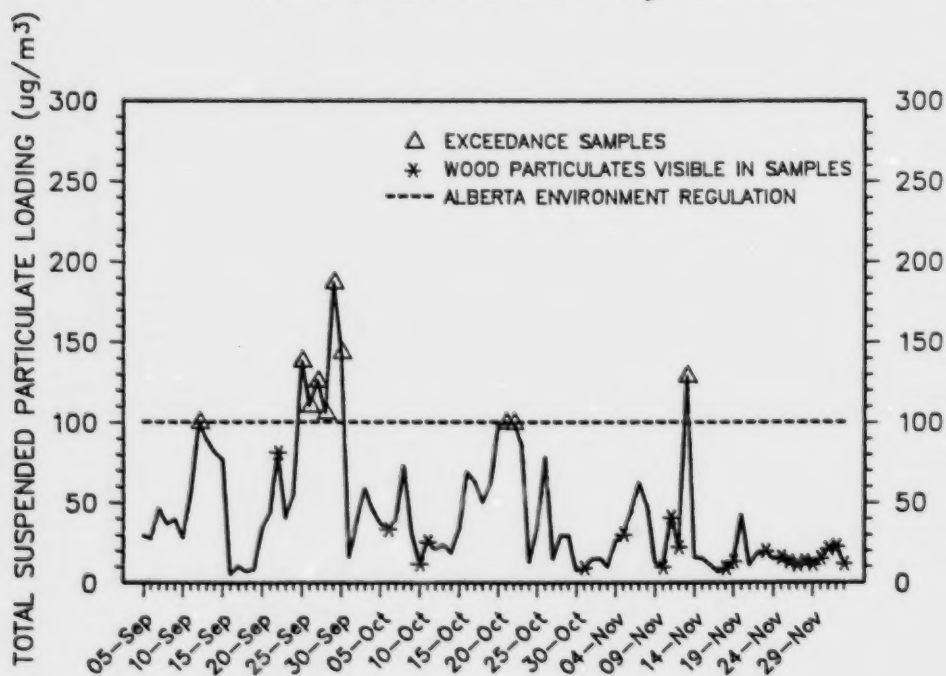


Figure 3-3 Total suspended particulate loading as a function of day at site #2

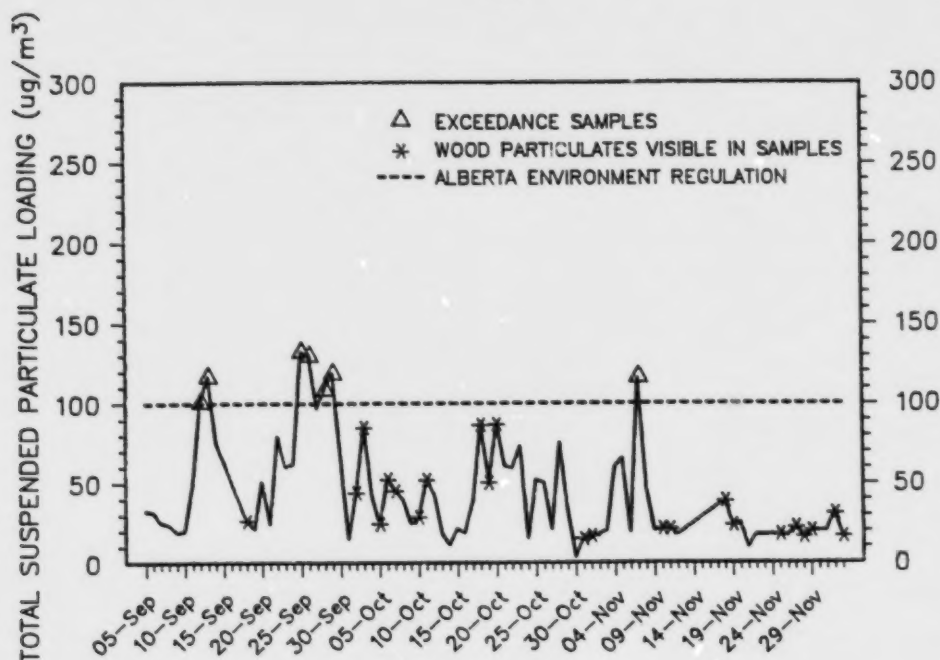


Figure 3-4 Total suspended particulate loading as a function of day at site #3

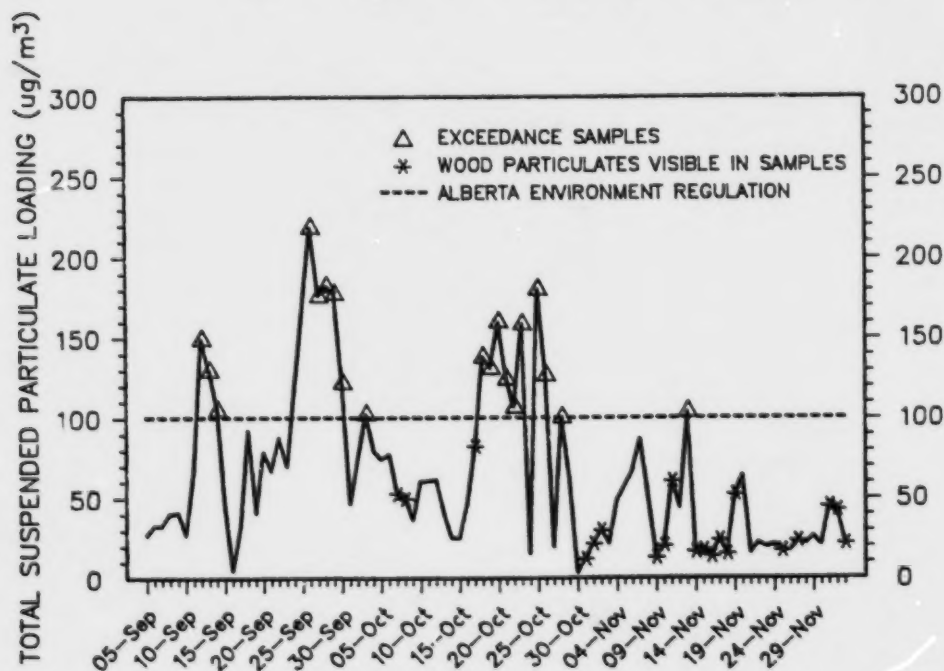


Figure 3-5 Total suspended particulate loading as a function of day at site #4

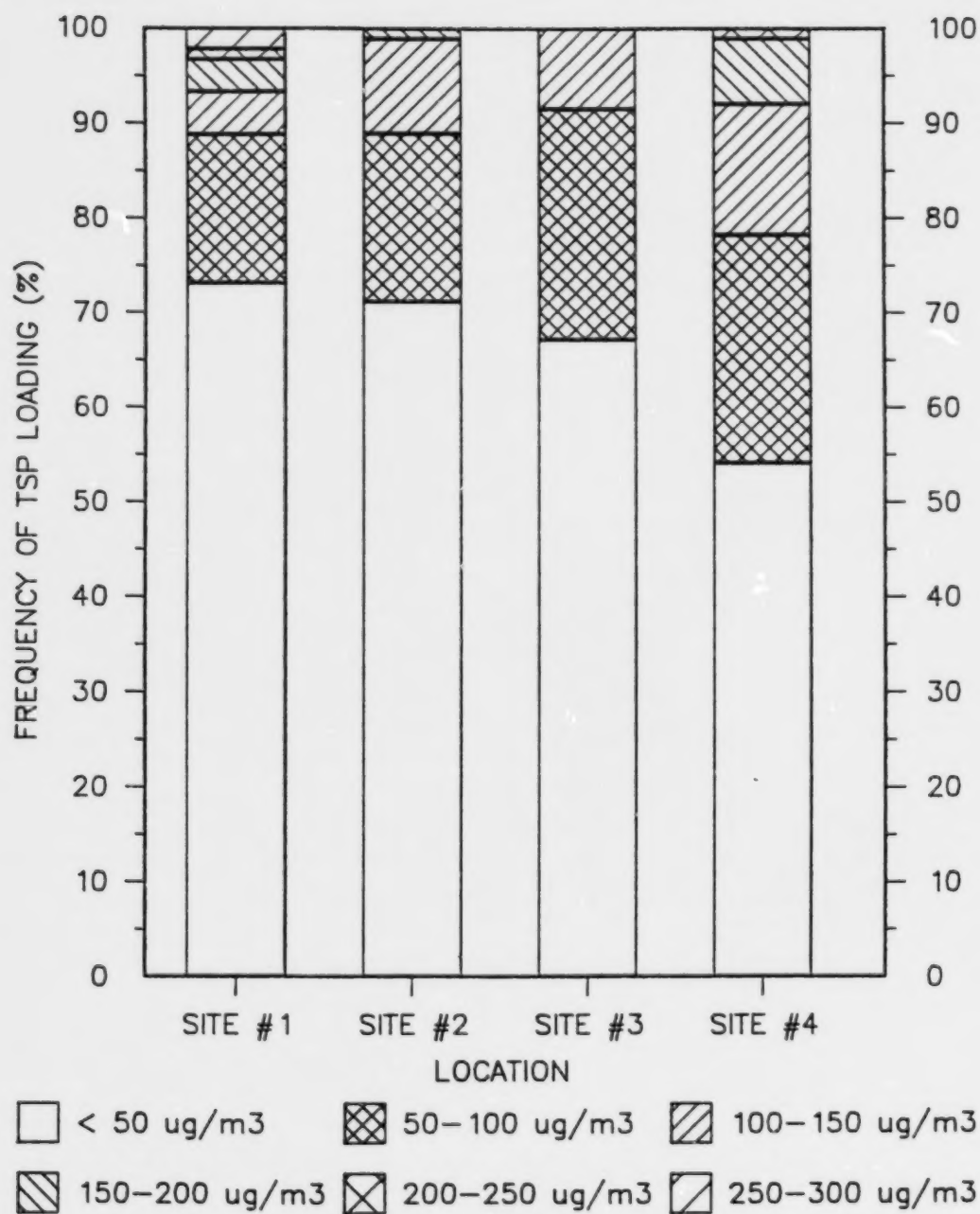


Figure 3-6 Frequency distribution of total suspended particulate loading

3.3.1 Exceedance Samples

Analysis of the 46 samples that exceeded $100 \mu\text{g}/\text{m}^3$ revealed that the majority of the particles present were dust, likely resulting from vehicular traffic and agricultural activity. Burned and unburned wood pieces were also present in exceedance samples.

A total of 21 days recorded an exceedance at one or more sites during the 90-day monitoring period. A wind direction frequency distribution for these days is presented in Figure 3-7. The most frequent wind directions were south through to southwest which were observed 32 percent of the time. Winds from the west-northwest, northwest and north-northwest also had a relatively high frequency of occurrence. Low frequencies of wind directions with an easterly component were observed.

3.3.2 Wood Particulate Samples

Electron microscope analysis was conducted on the 81 samples visually identified as containing wood particles. This analysis confirmed that the majority of the particles were unburned wood pieces, wood ash, ash particles, road dust and fibres.

During the monitoring program, a total of 38 days had samples from one or more stations which contained wood particles. Figure 3-8 shows a frequency distribution of wind direction for these days. Approximately half (51 percent) of the wind directions for wood particulate days were from the south through to the southwest. A significant minima in wind direction frequency is noted for winds from the northeast through to the east-southeast. Winds are relatively evenly distributed over the remaining wind directions.

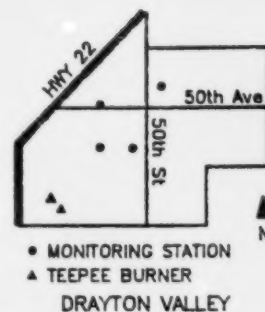
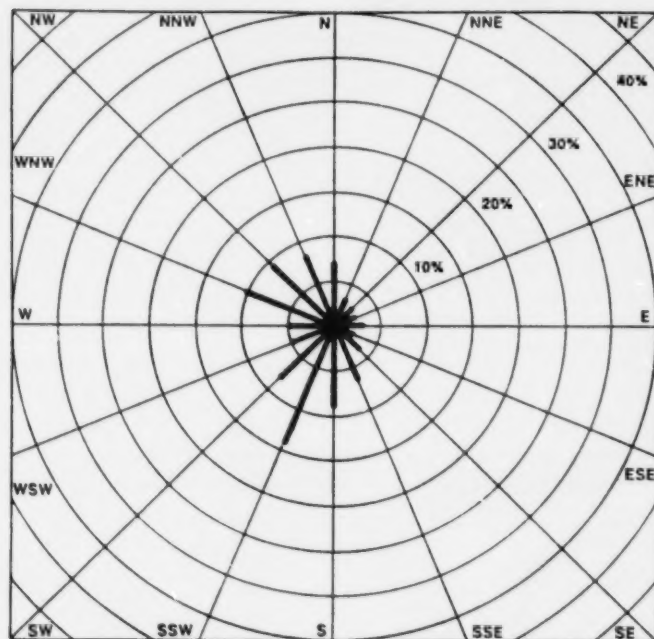


Figure 3-7 Wind direction frequency distribution for days on which exceedances were observed

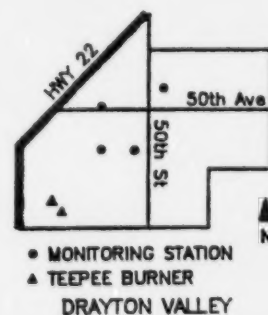
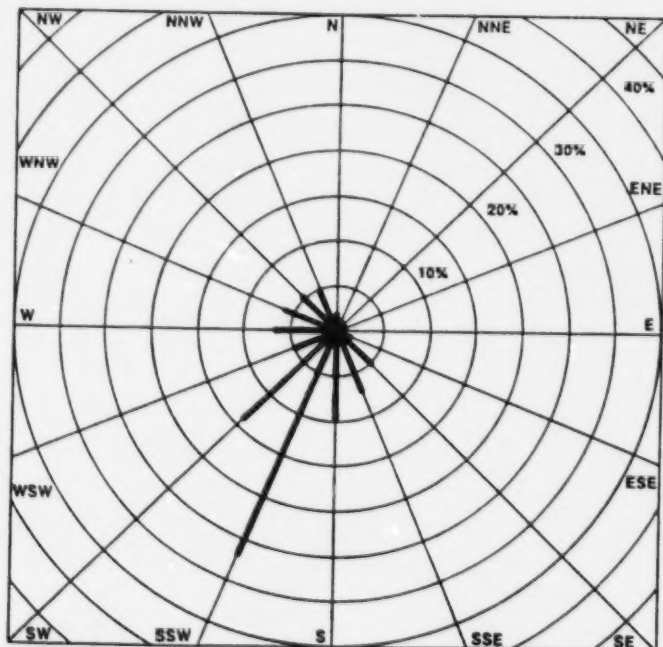


Figure 3-8 Wind direction frequency distribution for days on which wood particulates were observed

3.4 BENZO-a-PYRENE (BaP)

High pressure chromatography analysis was applied to the 15 samples with the highest TSP loadings and to the samples that were visually discolored by smoke. This analysis would reveal the loading of BaP in each sample.

Benzo-a-Pyrene loadings for the 15 samples with the highest TSP loadings are presented in Table 3.1. Generally, BaP loadings in these samples were relatively low, with the exception of the sample collected on September 29 at site #2 where a value of 12.5 $\mu\text{g/g}$ of particulate was observed. The average BaP loading for these 15 samples was 2.2 $\mu\text{g/g}$ of particulate. This value is about 8 percent of the average BaP loading for the month of November observed at the Edmonton air quality monitoring station located in the vicinity of 127 St. and 133 Ave.

A total of nine samples, visually discolored by smoke, were analyzed for the presence of BaP. Table 3.2 shows the results of this analysis. A maximum BaP loading of 44.1 $\mu\text{g/g}$ of particulate was observed on November 29 at site #1. This value is comparable to the peak value of 42.0 $\mu\text{g/g}$ of particulate observed on November 18 at the Edmonton air quality monitoring station at 127 St. and 133 Ave. The average BaP loading of the analyzed samples was 15.5 $\mu\text{g/g}$ of particulate. This value is approximately 55 percent of the average BaP observed at the Edmonton residential air quality trailer in November, but over twice that observed at the rural location of Ellerslie in November.

A wind direction frequency distribution for the days on which samples were visually discolored by smoke is presented in Figure 3-9. The predominant wind directions on these days were southwest and south-southwest. Approxi-

TABLE 3.1 BENZO-a-PYRENE (BaP) LOADING FOR THE 15 SAMPLES WITH THE HIGHEST TSP LOADINGS.

Date	Site #	BaP Loading ($\mu\text{g/g}$) ¹
September 25	1	1.1
September 26	1	1.2
September 26	4	0.6
September 27	1	1.0
September 27	4	1.0
September 28	1	0.8
September 28	4	1.3
September 29	1	0.4
September 29	2	12.5
September 29	4	0.4
October 20	1	3.4
October 20	4	3.2
October 23	4	1.5
October 25	4	2.8
November 13	2	2.0
AVERAGE		2.2

¹ μg of BaP per gram of particulate.

TABLE 3.2 BENZO-a-PYRENE (BaP) LOADING FOR SAMPLES WHICH WERE VISUALLY DISCOLORED BY SMOKE.

Date	Site #	BaP Loading ($\mu\text{g/g}$) ¹
November 18	1	3.1
November 18	2	3.5
November 23	2	8.9
November 27	1	14.8
November 27	2	8.6
November 27	4	8.7
November 28	1	35.5
November 29	1	44.1
December 2	2	12.5
AVERAGE		15.5

¹ μg of BaP per gram of particulate.

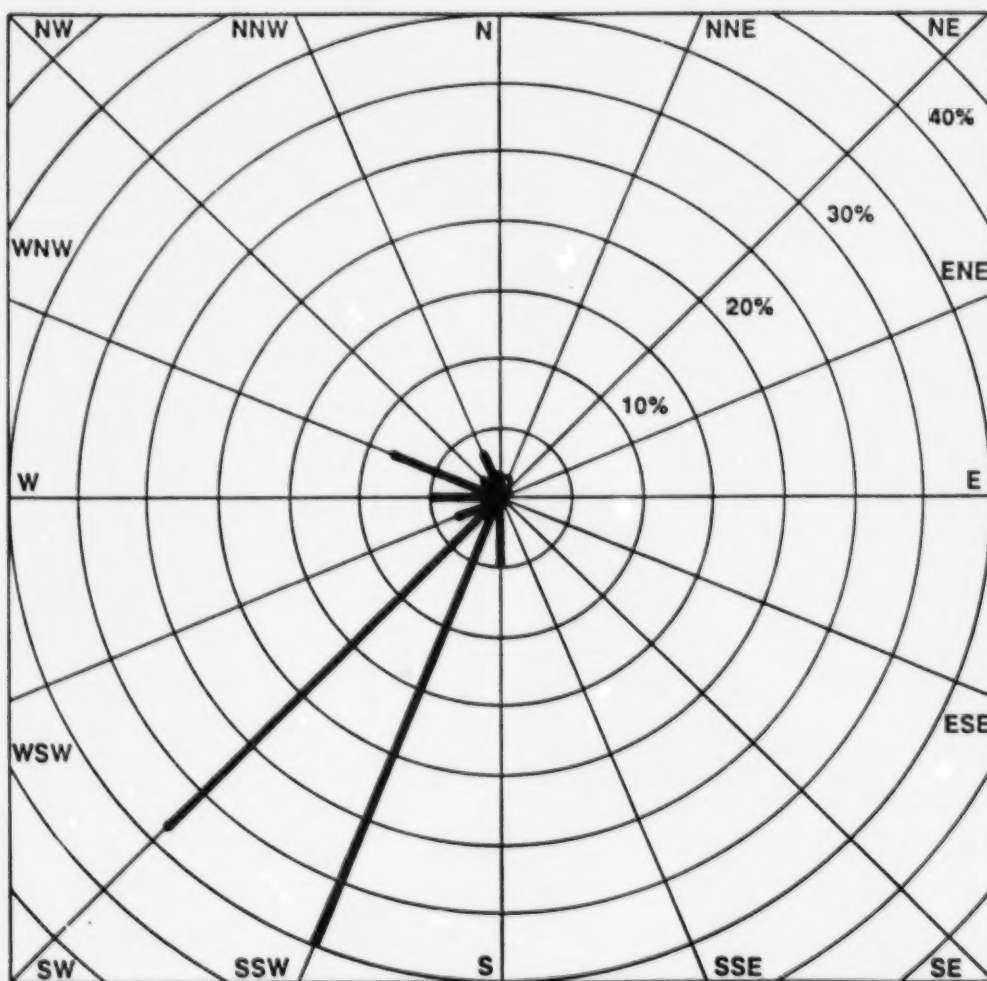
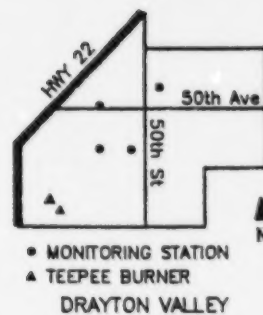


Figure 3-9 Wind direction frequency distribution
for days on which samples were visually
discolored by smoke

mately 70 percent of the winds were from these two directions. About 13 percent of the winds were from the west-northwest through to the north-northwest. The remaining wind directions contributed only a small portion to the total wind direction frequency distribution.

3.5 CONSTITUENTS OF PARTICULATE LOADING

A total of 24 samples were collected using a dichotomous sampler from November 10 to December 3, inclusive. EDXRF analysis was applied to 11 samples that were visually determined as having heavy particulate loading (black, grey, or brown color). This analysis revealed the loading of Pb, Br, Cl, Ca, Ti, Fe, K, Zn, Cu, and Cr in each sample. A detailed list of the EDXRF analysis is presented in Appendix 7.3.

For data analysis purposes, the constituents of particulate loading were grouped according to the most probable source. Mean values for coarse and fine particulates and associated sources are presented in Figures 3-10 and 3-11, respectively.

Lead was found in large quantities in all the fine particulate samples analyzed by EDXRF. Bromine was not found in any of the fine particulate samples. In the coarse particulate samples, Pb was identified at lower levels of loading. A maximum Pb loading of 63.3 mg/g of fine particulate was measured on November 17. The most probable sources of Pb and Br are vehicular emissions.

Calcium and Fe were found in most of the fine particulate samples and Ca, Fe, and Ti were observed in the majority of the coarse particulate samples analyzed. Calcium was the largest contributor of these three elements (Ca, Fe, and Ti) with a peak loading of 58.5 mg/g of fine particulate observed on

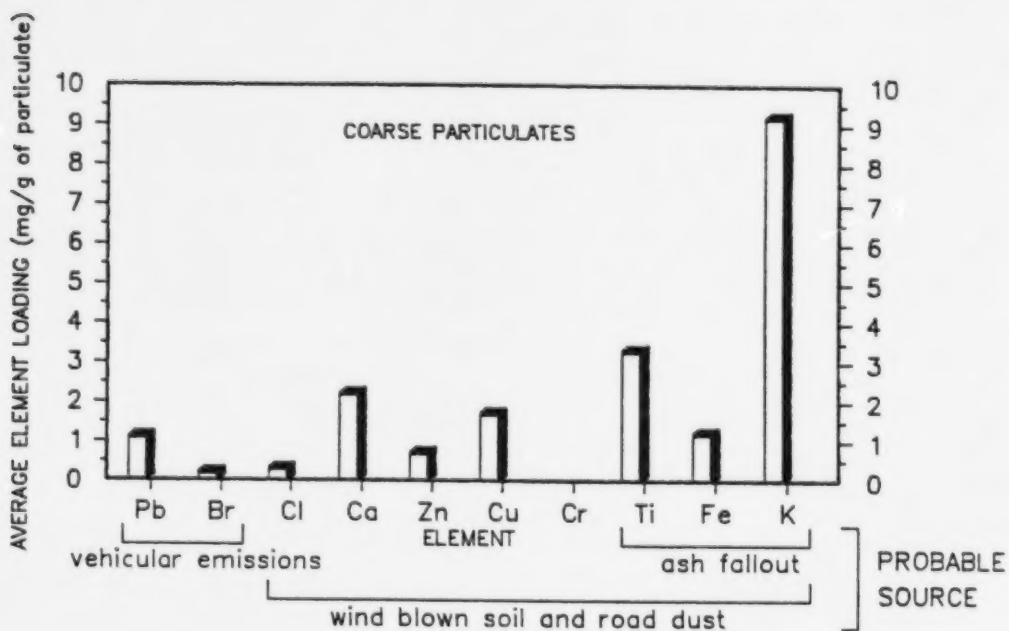


Figure 3-10 Average element loading for coarse particulates and probable sources

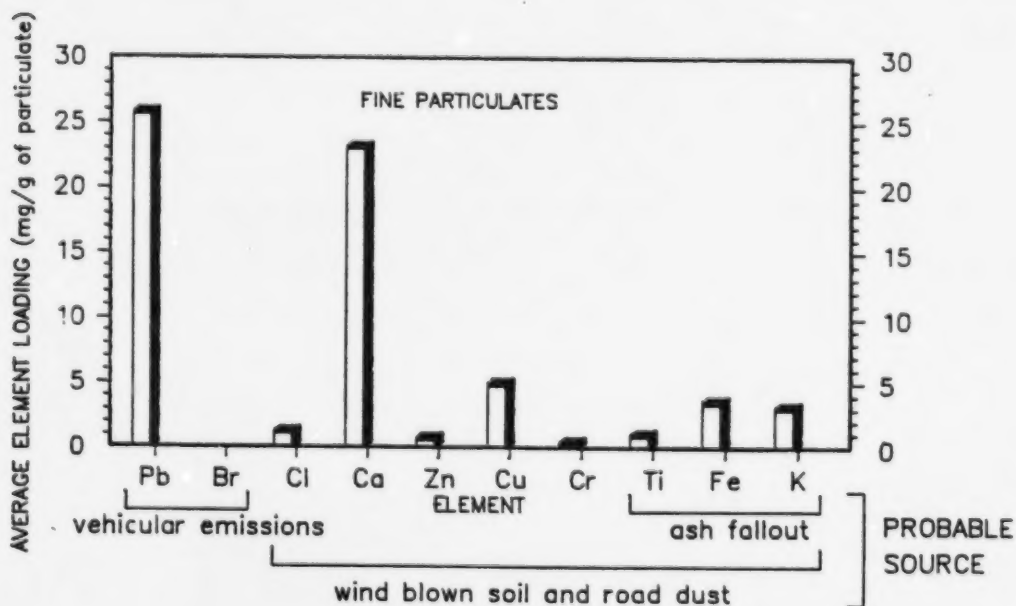


Figure 3-11 Average element loading for fine particulates and probable sources

November 18. Likely sources of Fe and Ti include wind blown soil and ash emissions from industrial or recreational wood burning sources. The major sources of Ca are wind blown soil and road dust.

Potassium, which will likely result from wood burning sources and wind blown soil, was identified in all of the samples analyzed for fine and coarse particulates. A maximum K loading of 33.2 mg/g of coarse particulate was found on November 18.

Zinc, copper, chlorine, and chromium were also found in some of the samples analyzed by EDXRF. The sources of these elements are most likely wind blown soil and road dust.

Figure 3-12 shows a wind direction frequency distribution for the 11 days on which the dichotomous samples had heavy particulate loadings. Winds from the southwest and south-southwest were observed over 40 percent of the time during these 11 days. Other wind directions occurred much less frequently. Winds with an easterly component were least frequent.

4. SUMMARY OF RESULTS

A total of 348 high volume samples collected were analyzed for total suspended particulate loading. About 13 percent of these samples exceeded the Alberta Environment air quality objective for TSP of $100 \mu\text{g}/\text{m}^3$ as a total for a 24-hour period. Approximately 23 percent of the samples were found to have particles resulting from the incineration of wood as the dominant particulate.

Days which had TSP loadings greater than $100 \mu\text{g}/\text{m}^3$ at one or more locations were analyzed as a function of wind direction. The wind direction frequency distribution for these days was similar to the wind direction frequency distribution for the entire monitoring period. This result implies

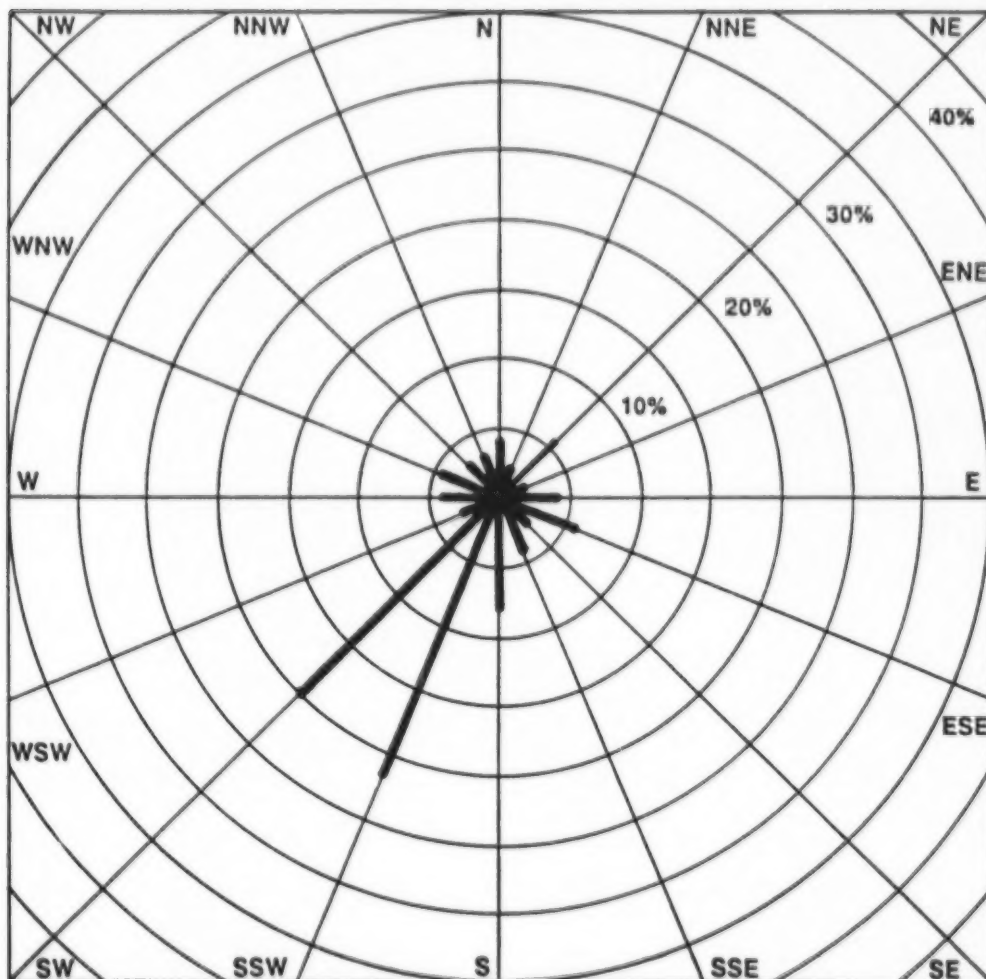
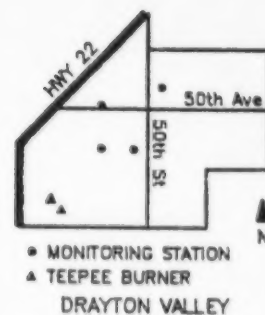


Figure 3-12 Wind direction frequency distribution
for days on which dichotomous samples
had heavy particulate loadings

that exceedances cannot be attributed to any individual wind direction. Particulate identification of samples collected on exceedance days show that the major contributor to exceedances is dust. This dust is likely the result of vehicular traffic along nearby roads and from agricultural practices conducted during September and October (harvest).

A wind direction frequency distribution for days on which particulates resulting from the burning of wood were observed was compared to the wind direction frequency distribution for the months of September, October and November. This comparison showed that a significantly greater frequency of wind directions from the southwest and south-southwest was evident on these days than over the entire monitoring period. Approximately 17 percent more winds from these directions were observed on wood particulate days (days on which wood particulates were observed at one or more monitoring locations). This result indicates that a source of wood particulates exists in the southwest and south-southwest areas of the Town of Drayton Valley.

Samples visually discolored by smoke were found to have similar BaP loadings as those observed at an urban Edmonton location for the same time period. BaP loadings were found to be low in samples with high TSP loadings.

A wind direction frequency distribution generated for days on which samples were visually discolored by smoke showed that approximately 70 percent of the winds were from the southwest and south-southwest directions on these days. From this result, it is evident that a source of smoke resides in the southwest or south-southwest areas of town.

The most prevalent elements in dichotomous samples analyzed for the primary constituents of particulate loading included Pb, Ca and K. The most

likely source of Pb is automobile emissions. Calcium may be emitted by wind blown soil while K is likely emitted by wood burning sources, wind blown soil and road dust. Titanium, iron, and copper were also detected in relatively high quantities. Smaller quantities of Zn, Cl, Br, and Cr were found.

Over 40 percent of wind directions were from the southwest and south-southwest for the days on which dichotomous samples were analyzed for the constituents of particulate loading. This result implies that a source of some of these elements may reside in the southwest and south-southwest areas of the Town of Drayton Valley.

Wood particulates, BaP and some of the elements of particulate loading were found to originate from sources in the southwest and south-southwest areas of town. Possible sources in those directions include wood manufacturing operations as well as recreational wood burning sources such as fireplaces and campfires.

5. CONCLUSIONS

Suspended particulates were monitored by a network of four high volume samplers and one dichotomous sampler during the autumn of 1989. The conclusions of this monitoring program are summarized as follows:

1. Total suspended particulate loadings exceeded the ambient air quality standards 13 percent of the time. The particulate matter on exceedance days consisted primarily of dust particles. A wind direction frequency distribution generated for exceedance days showed that the frequency of exceedances was not necessarily dependent on wind direction. The relatively low loadings of Benzo-a-Pyrene in samples with high TSP loadings suggest that sources emitting smoke made minor contributions to elevated TSP

loadings. The primary sources of dust in the Drayton Valley area are likely road dust and dust resulting from agricultural activities.

2. Wood particles were identified as the dominant particulate in 23 percent of the high volume samples. A wind direction frequency distribution of wood particulate days revealed that the major source of wood particulates was located in the southwest and south-southwest areas of town. None of these particulate samples contained loadings greater than the Alberta Environment regulation of $100 \mu\text{g}/\text{m}^3$.
3. Benzo-a-Pyrene was found in concentrations comparable to an urban location of Edmonton. The wind direction during high BaP episodes was out of the southwest and south-southwest 70 percent of the time. This indicates that a major source of BaP (likely wood smoke) exist in the southwest and south-southwest areas of Drayton Valley.
4. The primary constituents of the particulate samples collected by the dichotomous sampler were Pb, Ca and K. The most probable source of Pb is automobile emissions. Calcium (Ca) will naturally occur in wind blown soil and road dust while K is likely the result of wind blown soil, road dust or wood burning. Analysis of a wind direction frequency distribution indicates a source of some of these elements in the southwest and south-southwest areas of Drayton Valley.

6. REFERENCES

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7. APPENDICES

7.1 TOTAL SUSPENDED PARTICULATE DATA

TOTAL SUSPENDED PARTICULATE (TSP) DATA

Date Sampled	Site #1 TSP Loading (ug/m3)	Site #2 TSP Loading (ug/m3)	Site #3 TSP Loading (ug/m3)	Site #4 TSP Loading (ug/m3)
*****	*****	*****	*****	*****
05-Sep-89	17.5960	29.6000	31.9752	26.6024
06-Sep-89	24.4197	28.1456	31.1853	32.4479
07-Sep-89	29.6148	46.4790	24.8174	32.4452
08-Sep-89	44.8700	37.1283	23.4680	40.0560
09-Sep-89	47.5949	40.4585	18.8624	40.8900
10-Sep-89	20.8754	28.7282	19.8146	26.4840
11-Sep-89	48.8830	57.4320	49.1495	67.3374
12-Sep-89	119.0032	100.6656	100.6265	148.9631
13-Sep-89	101.1006	89.3203	116.6966	129.2577
14-Sep-89	75.8337	81.3371	75.1756	104.7470
15-Sep-89	39.7603	77.1652	NA	43.0075
16-Sep-89	2.7880	5.9760	NA	4.1384
17-Sep-89	9.4418	10.9801	NA	31.3908
18-Sep-89	14.1627	7.8031	26.4053	91.9654
19-Sep-89	11.1855	9.5704	20.9314	40.1254
20-Sep-89	43.6131	34.3337	50.5971	78.4214
21-Sep-89	25.8539	44.0208	24.2097	66.6391
22-Sep-89	67.5407	81.7879	79.0579	87.1902
23-Sep-89	42.1949	40.8106	60.1486	69.3461
24-Sep-89	51.3680	55.2405	62.0202	NA
25-Sep-89	183.7264	138.8441	132.1720	NA
26-Sep-89	264.3153	110.7181	129.7426	218.4993
27-Sep-89	190.2661	126.4282	96.6120	175.5312
28-Sep-89	269.6288	106.3969	108.4223	181.8485
29-Sep-89	222.1474	187.7665	118.7099	177.2779
30-Sep-89	47.9877	144.0403	67.0086	121.6625
01-Oct-89	14.9902	16.8324	14.8734	45.8601
02-Oct-89	55.5082	38.9444	44.0632	73.5723
03-Oct-89	94.6869	59.3141	84.9937	101.9872
04-Oct-89	37.7058	46.0476	41.1864	78.8618
05-Oct-89	23.9402	37.6600	24.5241	73.6291
06-Oct-89	45.8571	34.3901	52.3976	76.8782
07-Oct-89	53.5419	39.7092	45.1312	52.4203
08-Oct-89	82.6881	73.2592	39.2023	49.3786
09-Oct-89	25.5622	31.2125	24.6101	36.0198
10-Oct-89	16.4524	12.7637	28.7910	60.2532
11-Oct-89	34.3362	26.5881	52.1527	60.7321
12-Oct-89	28.2880	21.4499	42.5782	61.2365
13-Oct-89	37.7021	24.3606	17.9020	39.7402
14-Oct-89	13.7218	19.1288	11.0555	24.6356
15-Oct-89	35.5413	34.1995	21.3395	24.4219
16-Oct-89	15.9407	69.4849	18.3656	45.3696
17-Oct-89	30.8008	63.3324	38.7784	82.2103
18-Oct-89	63.5832	50.9969	86.5358	137.6588
19-Oct-89	80.8099	62.0119	50.1883	130.4345
20-Oct-89	174.6242	99.5574	86.8796	159.4667

NA - data not available due to instrument malfunction

TOTAL SUSPENDED PARTICULATE (TSP) DATA

Date Sampled	Site #1 TSP Loading (ug/m3)	Site #2 TSP Loading (ug/m3)	Site #3 TSP Loading (ug/m3)	Site #4 TSP Loading (ug/m3)
*****	*****	*****	*****	*****
21-Oct-89	107.9776	100.3681	60.2884	123.7625
22-Oct-89	80.8697	100.3259	58.8124	106.2110
23-Oct-89	72.8545	87.1163	72.8343	158.2045
24-Oct-89	13.3985	13.5440	15.1573	14.9669
25-Oct-89	NA	33.9993	51.9103	179.8434
26-Oct-89	103.7019	78.8550	49.7697	126.2755
27-Oct-89	19.9696	15.0877	20.8202	19.1176
28-Oct-89	54.0698	30.2464	74.9192	100.0629
29-Oct-89	31.3295	30.1467	33.0617	62.0245
30-Oct-89	8.0911	8.4587	2.9026	2.5785
31-Oct-89	11.1644	10.2843	15.0124	11.9589
01-Nov-89	19.3250	15.4569	16.8678	21.5462
02-Nov-89	20.9195	16.0301	18.0729	30.0248
03-Nov-89	7.1550	10.6016	20.3698	21.0207
04-Nov-89	14.3540	26.7594	59.6952	47.9022
05-Nov-89	18.6023	31.1747	65.1384	NA
06-Nov-89	14.2449	44.6351	18.7819	66.2033
07-Nov-89	53.0956	62.9179	115.5094	86.4456
08-Nov-89	35.2585	48.1656	45.9378	49.3288
09-Nov-89	29.1310	13.3882	19.8444	12.6723
10-Nov-89	12.4945	10.8874	21.5445	20.3200
11-Nov-89	12.4891	41.7899	21.2692	60.7834
12-Nov-89	15.8651	23.1153	17.2795	43.5011
13-Nov-89	79.7324	129.4938	NA	103.5948
14-Nov-89	15.2238	16.4219	NA	16.2721
15-Nov-89	17.3246	15.6057	NA	17.6046
16-Nov-89	11.6376	11.7894	NA	13.5272
17-Nov-89	11.9386	7.4077	NA	23.8694
18-Nov-89	36.7266	10.2112	38.8400	15.1072
19-Nov-89	7.2925	14.3104	23.6663	52.4667
20-Nov-89	18.6430	42.7642	24.9428	63.5828
21-Nov-89	19.9294	11.2889	9.5205	15.0881
22-Nov-89	22.6348	18.8145	17.4150	21.7576
23-Nov-89	19.5848	20.6314	17.5033	19.1842
24-Nov-89	17.5318	15.3963	17.6454	20.7976
25-Nov-89	17.4342	16.7056	17.7775	17.1669
26-Nov-89	16.0246	14.1416	16.4443	16.4554
27-Nov-89	26.2153	12.0812	22.3757	23.3414
28-Nov-89	25.1331	14.2426	16.3644	21.0083
29-Nov-89	24.3068	12.1994	20.1818	25.6069
30-Nov-89	19.3487	16.0905	19.7377	20.0387
01-Dec-89	17.1727	21.8727	20.1178	44.8533
02-Dec-89	25.3765	23.5159	31.1149	42.3197
03-Dec-89	16.7023	12.6504	16.5797	21.4773

NA - data not available due to instrument malfunction

7.2 PARTICLE IDENTIFICATION OF TOTAL SUSPENDED PARTICULATES

PARTICLE IDENTIFICATION OF TOTAL SUSPENDED PARTICULATES

EXCEEDANCE SAMPLES

Date Sampled	Station Number	Total Particulate Loading ug\m3	Particle Identification
*****	*****	*****	*****
12-Sep-89	1	119.0032	DBU
13-Sep-89	1	101.1006	DBUF
25-Sep-89	1	183.7264	DBU
26-Sep-89	1	264.3153	DBU
27-Sep-89	1	190.2661	DBU
28-Sep-89	1	269.6288	DBU
29-Sep-89	1	222.1474	DBU
20-Oct-89	1	174.6242	DBUF
21-Oct-89	1	107.9776	DBUF
26-Oct-89	1	103.7019	DBUFA
12-Sep-89	2	100.6656	DBU
25-Sep-89	2	138.8441	DBU
26-Sep-89	2	110.7181	DBU
27-Sep-89	2	126.4282	DBU
28-Sep-89	2	106.3969	DBU
29-Sep-89	2	187.7665	DBU
30-Sep-89	2	144.0403	DBU
21-Oct-89	2	100.3681	DBUF
22-Oct-89	2	100.3259	DBUF
13-Nov-89	2	129.4938	DBF

B - burned wood bits
U - unburned wood bits
A - ash
D - dust and grit
F - fibres (red,blue and black)

EXCEEDANCE SAMPLES

Date Sampled	Station Number	Total Particulate Loading ug\m3	Particle Identification
*****	*****	*****	*****
12-Sep-89	3	100.6265	DBUF
13-Sep-89	3	116.6966	DBU
25-Sep-89	3	132.1720	DBU
26-Sep-89	3	129.7426	DBUF
28-Sep-89	3	108.4223	DBU
29-Sep-89	3	118.7099	DBU
07-Nov-89	3	115.5094	DBU
12-Sep-89	4	148.9631	DBU
13-Sep-89	4	129.2577	DBU
14-Sep-89	4	104.7470	DBU
26-Sep-89	4	218.4993	DBU
27-Sep-89	4	175.5312	DBU
28-Sep-89	4	181.8485	DBU
29-Sep-89	4	177.2779	DBU
30-Sep-89	4	121.6625	DBU
03-Oct-89	4	101.9872	DBU
18-Oct-89	4	137.6588	DBUF
19-Oct-89	4	130.4345	DBUFA
20-Oct-89	4	159.4667	DBUF
21-Oct-89	4	123.7625	DF
22-Oct-89	4	106.2110	DBUF
23-Oct-89	4	158.2045	DBU
25-Oct-89	4	179.8434	DBUFA
26-Oct-89	4	126.2755	DBUF
28-Oct-89	4	100.0629	DFBU
13-Nov-89	4	103.5948	DBU

B - burned wood bits
 U - unburned wood bits
 A - ash
 D - dust and grit
 F - fibres (red,blue and black)

WOOD PARTICULATE SAMPLES

Date Sampled	Station Number	Total Particulate Loading ug\m3	Particle Identification
*****	*****	*****	*****
06-Oct-89	1	45.8571	BUAD
10-Oct-89	1	16.4524	BUADF
11-Oct-89	1	34.3362	BUAD
31-Oct-89	1	11.1644	BUAF
09-Nov-89	1	29.1310	BUAF
10-Nov-89	1	12.4945	BUAF
11-Nov-89	1	12.4891	BUAF
17-Nov-89	1	11.9386	BUA
18-Nov-89	1	36.7266	BUA
19-Nov-89	1	7.2925	BUAF
23-Nov-89	1	19.5848	BUAF
25-Nov-89	1	17.4342	BUA
27-Nov-89	1	26.2153	BUAF
28-Nov-89	1	25.1331	BUA
29-Nov-89	1	24.3068	BUA
02-Dec-89	1	25.3765	BUAF
03-Dec-89	1	16.7023	BUA

B - burned wood bits
 U - unburned wood bits
 A - ash
 D - dust and grit
 F - fibres (red,blue and black)

WOOD PARTICULATE SAMPLES

Date Sampled	Station Number	Total Particulate Loading ug\m3	Particle Identification
*****	*****	*****	*****
31-Oct-89	2	10.2843	BUF
05-Nov-89	2	31.1747	DBUF
10-Nov-89	2	10.8874	DBUF
11-Nov-89	2	41.7899	BUDAF
12-Nov-89	2	23.1153	BUAD
18-Nov-89	2	10.2112	BUA
19-Nov-89	2	14.3104	BUAF
23-Nov-89	2	20.6314	BUAF
25-Nov-89	2	16.7056	BUAF
26-Nov-89	2	14.1416	BUAF
27-Nov-89	2	12.0812	BUAF
28-Nov-89	2	14.2426	BUAF
29-Nov-89	2	12.1994	BUAF
30-Nov-89	2	16.0905	BUAF
01-Dec-89	2	21.8727	BUAF
02-Dec-89	2	23.5159	BUAF
03-Dec-89	2	12.6504	BUAF

B - burned wood bits
 U - unburned wood bits
 A - ash
 D - dust and grit
 F - fibres (red,blue and black)

WOOD PARTICULATE SAMPLES

Date Sampled	Station Number	Total Particulate Loading ug\m3	Particle Identification
*****	*****	*****	*****
18-Sep-89	3	26.4053	BU
02-Oct-89	3	44.0632	BUD
03-Oct-89	3	84.9937	BUD
05-Oct-89	3	24.5241	BUAF
06-Oct-89	3	52.3976	BUA
07-Oct-89	3	45.1312	BUAD
10-Oct-89	3	28.7910	BUAF
11-Oct-89	3	52.1527	BUADF
18-Oct-89	3	86.5358	BUAF
19-Oct-89	3	50.1883	BUAFD
20-Oct-89	3	86.8796	BUAF
31-Oct-89	3	15.0124	BUAF
01-Nov-89	3	16.8678	BUAF
10-Nov-89	3	21.5445	BUDA
11-Nov-89	3	21.2692	BAUDF
18-Nov-89	3	38.8400	BUA
19-Nov-89	3	23.6663	BUADF
25-Nov-89	3	17.7775	BUAF
27-Nov-89	3	22.3757	BUAF
28-Nov-89	3	16.3644	BUAF
29-Nov-89	3	20.1818	BUA
02-Dec-89	3	31.1149	BUADF
03-Dec-89	3	16.5797	BUF

B - burned wood bits
 U - unburned wood bits
 A - ash
 D - dust and grit
 F - fibres (red, blue and black)

WOOD PARTICULATE SAMPLES

Date Sampled	Station Number	Total Particulate Loading ug\m3	Particle Identification
*****	*****	*****	*****
17-Oct-89	4	82.2103	BUAD
31-Oct-89	4	11.9589	BUADF
01-Nov-89	4	21.5462	BUADF
02-Nov-89	4	30.0248	BUADF
09-Nov-89	4	12.6723	BUAD
10-Nov-89	4	20.3200	BUADF
11-Nov-89	4	60.7834	BUAD
14-Nov-89	4	16.2721	BUF
15-Nov-89	4	17.6046	BUAF
16-Nov-89	4	13.5272	BUAF
17-Nov-89	4	23.8694	BUAF
18-Nov-89	4	15.1072	BUA
19-Nov-89	4	52.4667	BUADF
25-Nov-89	4	17.1669	BUA
27-Nov-89	4	23.3414	BUAF
01-Dec-89	4	44.8533	BUADF
02-Dec-89	4	42.3197	BUADF
03-Dec-89	4	21.4773	BUAF

B - burned wood bits
 U - unburned wood bits
 A - ash
 D - dust and grit
 F - fibres (red,blue and black)

7.3 EDXRF ANALYSIS OF DICHOTOMOUS DATA

ENERGY DISPERSIVE X-RAY FLUORESCENCE ANALYSIS OF DICHOTOMOUS DATA

Primary Constituents of Particulate Loading (mg/g)

		Date Sample #					
		NOV 13 #4		NOV 17 #8		NOV 18 #9	
Element		Fine	Coarse	Fine	Coarse	Fine	Coarse
Pb		7.26	1.98	63.25		12.54	
Br							
Cl							
Ca		48.46	7.13	9.9	3.58	58.46	
Ti		1.91					5.79
Fe		12.68	3.17	1.12	1.23		1.25
K		4.16	6.87	0.99	3.77	7.34	33.16
Zn							
Cu							
Cr							

		Date Sample #					
		NOV 20 #11		NOV 21 #12		NOV 22 #13	
Element		Fine	Coarse	Fine	Coarse	Fine	Coarse
Pb		54.14	1.82	13.3	1.2	27.07	
Br					0.42		
Cl							
Ca		52.48	2.89	10.19		8.25	2.38
Ti					3.96	2.81	4.69
Fe		5.28	2.31	3.49		4.29	
K		3.3	0.5	1.13	1.92	1.16	0.99
Zn				1.98	0.66	0.99	0.39
Cu				20.18	5.04	9.74	
Cr				0.85		1.82	

Primary Constituents of Particulate Loading (mg/g)

		Date Sample #					
		NOV 24 #15		NOV 25 #16		NOV 27 #18	
Element		Fine	Coarse	Fine	Coarse	Fine	Coarse
Pb		14.15	3.83	25.42		15.84	
Br			1.06				
Cl						0.99	
Ca		12.07	5.02	18.82	1.6	2.2	
Ti		1.98	2.64	3.3	0.77		6.16
Fe		3.68	2.24	3.47	1.87	0.55	
K		0.94	3.96	1.49	0.65	6.71	33.01
Zn		0.66	1.06		0.39	0.88	2.86
Cu		0.47	0.79		0.33		0.66
Cr							

		Date Sample #			
		NOV 28 #19		NOV 29 #20	
Element		Fine	Coarse	Fine	Coarse
Pb		32.35		17.82	3.49
Br					1.13
Cl			3.3	12.54	
Ca		23.99		9.35	1.51
Ti			2.42	0.66	9.43
Fe		3.08		1.76	0.94
K		5.5	13.42	1.76	2.74
Zn		1.76	1.98	0.77	0.47
Cu		23.77	11.88		
Cr				1.21	